Hamakua Marsh (Kailua, Oʻahu) restoration site 2010 plant monitoring survey

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Introduction

This report is the second monitoring report for a wetlands restoration project at Hamakua Marsh, Kailua, windward Oʻahu (Fig. 1). The purpose of this report is to document progress towards a wetland restoration that began in April-May 2008 as measured by the results of vegetation transects undertaken approximately two years following restoration. Restoration and monitoring requirements are detailed in a Removal/Restoration Plan (SWCA, 2006) in compliance with agreements reached with the U.S. Environmental Protection Agency (EPA) arising from Docket No. CWA-404-309 (a)-06-007 (EPA, 2006) for placing fill material in a wetland located on property owned by Kaneohe Ranch Company.

The restoration site is located on a triangular parcel (TMK: 4-2-003:29) adjacent to Kawai Nui Stream ("Hamakua" Stream in some sources) and is part of the Kaelepulu-Hamakua drainage canal (Fig. 1). Because some of this area was previously a wetland along a drainage channel and fill was placed without a Dept. of the Army permit, restoration back to wetland conditions was required by EPA.

Survey Methods

To date, four separate plant surveys have been conducted at the Hamakua Marsh restoration site. An initial survey made in May 2008 produced a non-quantitative listing of plants representing conditions during the early stage of

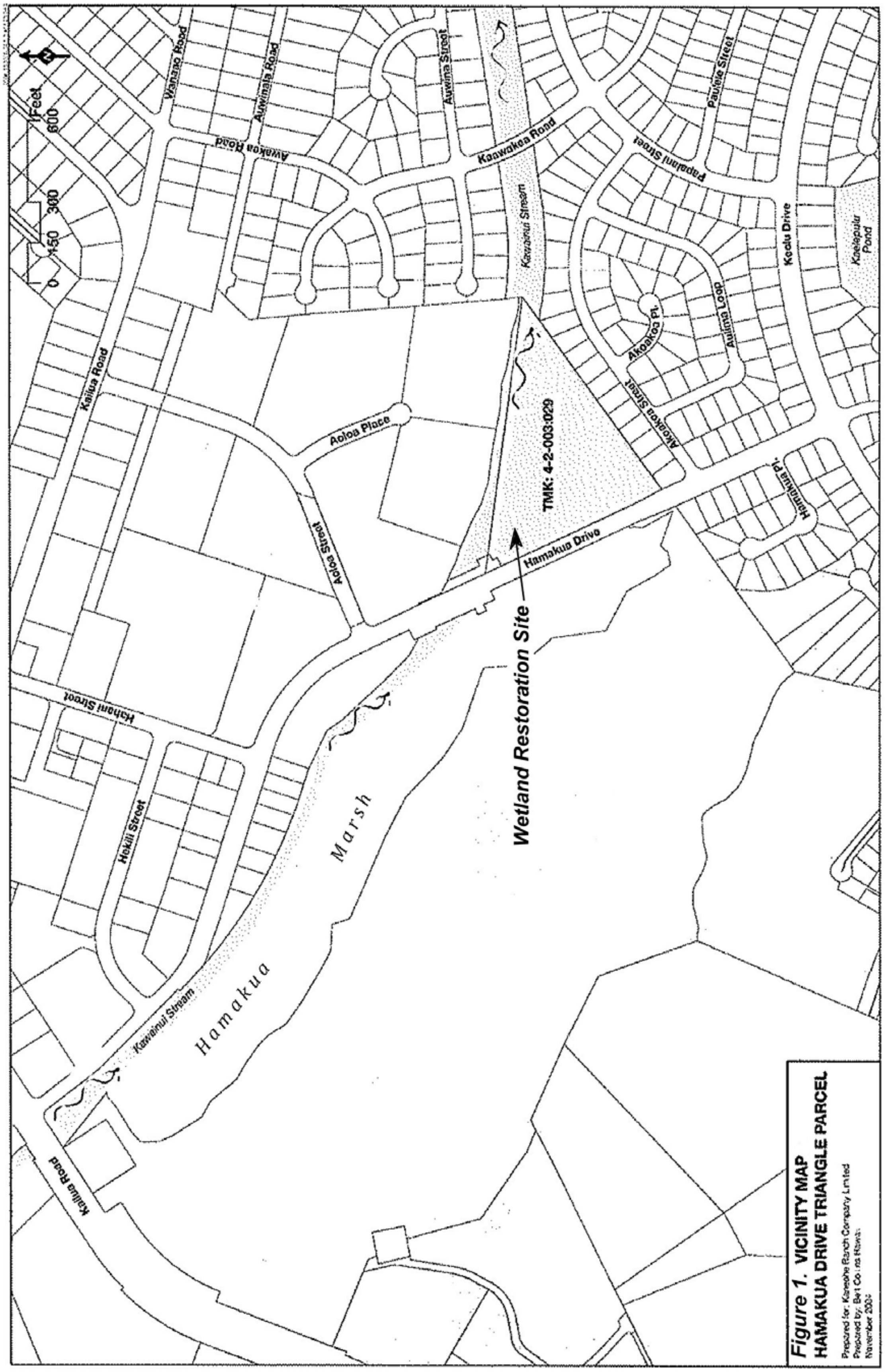

Figure 1. **VICINITY MAP HAMAKUA DRIVE TRIANGLE PARCEL**

Prepared for: Kaneohe Ranch Company Limited
Prepared by: Belt Collins Hawaii
November 2004

physical alteration (grading) of the site. This plant species list is given in *AECOS* (2009). *AECOS* undertook a second quantitative (transect) survey on September 22, 2008. Although representing post-restoration conditions, most of the plantings that had been made in June and August of 2008 had failed to survive. Additional plantings were then made throughout November 2008 (Matt Schirman, Hui Kū Maoli Ola, pers. comm.). Consequently, *AECOS* undertook a third plant survey on April 14, 2009. Plantings had by this time taken hold and this survey constituted the first official monitoring of the restoration effort (*AECOS*, 2009). The second-year post-construction survey was conducted on June 25, 2010 and the results are presented here.

For the June 2010 survey, vegetation abundance data were obtained from two transects laid along the margins of the restored depression; total transect length was 109 m. The transect placements were limited to the margins of the restored area because very few plants were growing within the shallow pond and mud flat inside the site margin (Fig. 2).

Figure 2. June 2010 View across central part of basin, showing vegetation limited to the margin of the basin (marked by silt curtain). Note the two Hawaiian stilt on far side of pond.

A metric measuring tape was used to layout the transects. Transect 1 extended to the NE along the southeastern "shore" for a distance of 64.5 m, the line bending to roughly parallel the shoreline (Fig. 3). This was close to the alignment laid out in May 2009. Transect 2 (45 m long) was laid from the base (0 m point) of Transect 1, but in a westerly direction along the south shore for a distance of 44.5 m (Fig. 4) in the same general alignment as was used in May 2009, although for a much greater distance. The location of each end of the two transects was recorded with a Trimble GeoXT GPS unit.

Figure 3. Transect 1 from base (foreground) laid out in June 2010.

Figure 4. South side of the restoration site on June 25, 2010 showing Transect 2 in place. Transect extends farther than in April 2009 (44.5 m vs. 20 m) because in 2009 the far corner was barren of vegetation and underwater.

An aluminum quadrat frame of dimensions 1.0 by 0.5 m, outfitted with a grid of heavy sugi thread spaced at 10 cm intervals, was used to quantify plant cover. The quadrat frame was placed along a transect (centered on the line) every 0.5 m (see Fig. 4 in *AECOS*, 2009). This approach created a sampling area that was 1-m wide by the length of each transect for a total sampling area of 109 m^2.

Once the quadrat frame was positioned, the biologist considered each of the 50 10 x 10 cm squares and recorded the dominant (covering 50% or greater) plant species (or "bare substratum," "leaf litter," "water", or "caliche" in some cases) within a square. The result of these counts is an estimate of the percent coverage for each species or bottom type within a quadrat, where each scoring represents 2% (1/50) of the 0.5 m^2 quadrat area. This method examined 218 contiguous quadrats and proved reasonably efficient to complete in the field, although clearly biased to the shore area as discussed above.

Results

Quadrat counts from the April 14, 2009 transects (at completion of construction and replanting) and the June 25, 2010 transects (at two years following final grading of the basin) are summarized in Table 1. Quadrat data from the June 2010 survey are presented in Appendix A.

Table 1. Results of post-construction wetland plant surveys of April 14, 2009 and June 25, 2010; average percent cover by plants and bare ground on two transects.

	April 2009	June 2010
BARE SUBSTRATUM (Dry)	85.1	71.0
WATER OVER BARE SUBSTRATUM (Flooded)	3.4	--
WETLAND PLANTS		
Cyperus javanicus (*ʻahuʻawa*)	8.3	12.7
Bacopa monieri (*ʻaeʻae*)	--	9.1
Bolboschoenus maritimus (*kaluhā*)	0.6	2.0
Cladium jamaicense (*ʻuki*)	0.3	0.9
Cyperus trachysanthos (*puʻu kaʻa*)	<0.1	--
Rhizophora mangle (mangrove)*	--	0.5
Batis maritima (pickleweed)*	--	<0.1
dead plant matter (planted, but not surviving)	0.5	0.1
WETLAND MARGIN PLANTS		
Pluchea spp.*	<0.1	0.1
Heliotropium curassavicum (kīpūkai)	--	1.2
UPLAND PLANTS (native species)		
Myoporum sandwicense (*naio*)	1.8	0.8
Scaevola taccada (*naupaka kahakai*)	0.6	1.0
Colubrina asiatica (*ʻānapanapa*)	0.3	0.4
Dodonaea viscosa (*ʻaʻaliʻi*)	<0.1	0.1
Jacquemontia ovalifolia (*pāʻū o hiʻiaka*)	<0.1	<0.1
MISCELLANEOUS WEEDS (FAC OR UPLAND PLANTS)		
non-native herbs*	0.2	<0.1

* indicates non-native species

Fig. 5 shows the south through west shore of the wetland depression as it appeared in September 2008. This view is aimed along Transect 1 in the opposite direction of that shown in Fig. 3. Considerably more water was present at this time (and in April 2009) than was the case on June 25, 2010.

Figure 5. Hamakua Marsh restoration site as it appeared in September 2008 with grading completed and initial plantings made. View is along shore of Transect 1 (foreground) and Transect 2 (background).

Conclusions

The purpose of the vegetation monitoring is to confirm that a vegetated wetland with certain wetland values has become established. Vegetation is the most practical way to interpret whether a wetland has or has not been established. Quantitative coverage values by species can be used to assess whether restoration goals have been met. The site has been physically restored, plantings made, and most of the shallow margin populated by native, emergent herbaceous and woody vegetation surviving and spreading from these plantings.

Plant cover as of June 2010 could be described as moderate with some 71% of the transect area lacking vegetation (Table 1). Since the previous survey in May 2009 (when bare substratum was 89% of the transect area), the plants have spread along the margin of the graded basin and are beginning to appear in

areas not covered by the transects. It is anticipated that over time, plants could cover much of the basin area, although the inundation history of the site is unclear. The central area may or may not remain unvegetated, depending upon the regularity of flooding. However, EPA's Findings of Violation and Order for Compliance dated April 2006 specifies that between 25% and 100% of the area should remain as open water (or less than 75% dominated by plant cover) to provide wading habitat for *Ae'o* or Hawaiian stilt (*Himantopus mexicanus knudseni*). *Ae'o* are utilizing the restoration area and two were observed in the central pond in June 2010.

Our transects are not representative of the site as a whole, only of the margin of the basin. Presently, vegetation occupies less than 5% of the entire area. Some plants are appearing on the bottom of the eastern half of the basin, in the area of failed plantings made in June through August, 2008. Consideration to conducting a transect across this area will be given at the next monitoring event scheduled for early summer, 2011.

The vegetation present at the Hamakua Marsh restoration site is nearly entirely native plants. Within the transect area, less than 0.8% of the area is occupied by non-native plants. Two species of concern, mangrove (*Rhizophora mangle*) and pickleweed (*Batis maritima*), are appearing in the wetland. The recording of mangrove in Transect 2 represents rooted seedlings. The numbers of these plants are presently small, but both are capable of dominating the site. Unfortunately these species are the dominant wetland vegetation just outside the boundary restoration area.

References

AECOS, Inc. (*AECOS*). 2009. Hamakua Marsh (Kailua, O'ahu) restoration site, plant monitoring survey. Prep. for Bureau Veritas North America, Inc. *AECOS* No. 1174A: 20 pp.

SWCA Environmental Consultants (SWCA). 2006. Revised Hamakua Drive Wetland Removal & Restoration Plan, Kailua, Oahu, Hawaii, EPA Docket No. CWA-404-309 (a)-06-007.

U. S. Environmental Protection Agency (EPA). 2006. Findings of Violation and Order for Compliance under Sections 308 and 309(a) of the Clean Water Act, EPA Docket No. CWA No. CWA-404-309(a)-06-007. April 24, 2006.

Appendix A

Quadrat Results by Transect - June 25, 2010

Position Data (UTM):

Transect 1, 0 m mark – 630761.8 m E / 2365560.8 m N
Transect 1, 32.5 m mark – 630789.5 m E / 2365576.5 m N
Transect 1, 50.0 m mark – 630806.9 m E / 2365576.6 m N
Transect 1, 64.5 m mark – 630820.9 m E / 2365576.7 m N

Transect 2, 0 m mark – 630761.8 m E / 2365561.4 m N
Transect 2, 45.0 m mark – 630748.7 m E / 2365602.0 m N

Transect 1	WETLAND PLANTS						dead
QUADRAT	'Ahu'awa	Kaluha	'Ae'ae	'Uki	Rhizoph.	Batis	'Ahu'awa
0							
0.5	1						
1	3						
1.5	42						
2	50						
2.5	50						
3	50						
3.5	49		1				
4	48						
4.5	45		1	2			
5			11	39			
5.5	7		29	11			
6	20		30				
6.5	14		29	7			
7			36	2			
7.5			7		1		
8							
8.5							
9							
9.5							
10							
10.5					1		
11			3	6			
11.5		not recorded					
12				27			
12.5	1		10				
13			26				2
13.5			5				
14			3				3
14.5	4		1				
15			3				1
15.5	1						1
16							2
16.5	1						
17							
17.5							
18	2						
18.5	4						
19			2				
19.5	2						1
20							
20.5							
21							
21.5			4				

Transect 1	UPLAND PLANTS							Bare
QUADRAT	H. Curr	Pluchea	Naupaka	Naio	A'ali'i	Colubrina	Jacquem.	substr.
0								50
0.5								49
1	4							43
1.5								8
2								
2.5								
3								
3.5								
4								2
4.5								2
5								
5.5								3
6								
6.5								
7								12
7.5								42
8								50
8.5								50
9								50
9.5								50
10								50
10.5								49
11								41
11.5		not recorded						
12								23
12.5	1							38
13								22
13.5								45
14								44
14.5	1							44
15								46
15.5								48
16								48
16.5								49
17								50
17.5								50
18								48
18.5								46
19								48
19.5								47
20								50
20.5								50
21								50
21.5	1							45

Transect 1	WETLAND PLANTS						dead
QUADRAT	'Ahu'awa	Kaluha	'Ae'ae	'Uki	Rhizoph.	Batis	'Ahu'awa
22	10		1				
22.5	47		1				
23	47		2				
23.5	47		1				
24	48						
24.5	42						
25	48						
25.5	43						
26	49						
26.5	23						
27	1						
27.5							
28							
28.5							
29							
29.5	2						
30	29						
30.5	41		1				
31	35		1				
31.5	10		1				
32	7						
32.5							
33	1						
33.5							
34	12						
34.5	4						
35	13						
35.5	16						
36	4						
36.5							
37	2						
37.5	1						
38	2						
38.5	1						
39	4						
39.5	1						
40	1						
40.5	10						
41	20						
41.5	15						
42	19						
42.5	34						
43	34						
43.5	5						

Transect 1	UPLAND PLANTS							Bare
QUADRAT	H. Curr	Pluchea	Naupaka	Naio	A'ali'i	Colubrina	Jacquem.	substr.
22		1						38
22.5								2
23								1
23.5		2						
24								2
24.5		1						7
25								2
25.5		1						6
26								1
26.5					4	1		22
27	1	1				1		47
27.5		2						48
28								50
28.5								50
29								50
29.5								48
30			7					14
30.5								8
31								14
31.5								39
32								43
32.5								50
33								49
33.5			4					46
34			7					31
34.5								46
35								37
35.5								34
36								46
36.5								50
37								48
37.5								49
38								48
38.5								49
39								46
39.5								49
40								49
40.5								40
41								30
41.5				2				33
42		1					2	28
42.5								16
43				2				14
43.5				9			2	34

Transect 1	WETLAND PLANTS						dead
QUADRAT	'Ahu'awa	Kaluha	'Ae'ae	'Uki	Rhizoph.	Batis	'Ahu'awa
44	1						
44.5	4						
45	6						
45.5	26						
46	26						
46.5	12						
47	4						
47.5	8						
48	24						
48.5	15						
49	18						
49.5	4						
50	3						
50.5	1						
51	2						
51.5	2						
52	8						
52.5	4						
53							
53.5							
54							
54.5							
55							
55.5							
56							
56.5							
57							
57.5							
58	3						
58.5							
59							
59.5							
60	24		4				
60.5	23						
61	3		12				
61.5			3				
62	5						
62.5	19						
63	11						
63.5							
64	1						

Transect 1	UPLAND PLANTS							Bare
QUADRAT	H. Curr	Pluchea	Naupaka	Naio	A'ali'i	Colubrina	Jacquem.	substr.
44				12				37
44.5				5				41
45				8				36
45.5								24
46				4				20
46.5				12				26
47				6				40
47.5			2	14				26
48			9	2				15
48.5			1	4	1	1		28
49				2		1		29
49.5					6			40
50		1				1		45
50.5				3				46
51				7		3		38
51.5						9		39
52								42
52.5								46
53								50
53.5						2		48
54			1			19		30
54.5			6			4		40
55			7					43
55.5			1					49
56								50
56.5			4					46
57			24					26
57.5			5					45
58			10					37
58.5			10			1		39
59								50
59.5								50
60								22
60.5						2		25
61								35
61.5								47
62								45
62.5			2					29
63			10					29
63.5	3							47
64	20							29

Transect 2	WETLAND PLANTS						dead	
QUADRAT	'Ahu'awa	Kaluha	'Ae'ae	'Uki	Rhizoph.	Batis	'Ahu'awa	caliche
0								
0.5								
1								
1.5								
2								
2.5								
3								
3.5			2	2		1		
4			1			1		
4.5			2					
5			1					
5.5			18					
6	4		26					
6.5			46		2			
7			50					
7.5			50					
8			49		1			
8.5			50					
9			41					
9.5			34		1			
10			32					
10.5			36					
11			40					
11.5			34					
12			32					
12.5		9	9					
13		6	9					
13.5			8		2			38
14			1					49
14.5			6		1			42
15								49
15.5								50
16								46
16.5								50
17								50
17.5								46
18		1	5					38
18.5								38
19								50
19.5			1					11
20		9	19					
20.5		17	10		4			
21		13	16					
21.5		14	27		1			

Transect 2	UPLAND PLANTS							Bare
QUADRAT	H. Curr	Pluchea	Naupaka	Naio	A'ali'i	Colubrina	Jacquem.	substr.
0								50
0.5								50
1								50
1.5								50
2								50
2.5								50
3								50
3.5								45
4								48
4.5								48
5								49
5.5								32
6								20
6.5								2
7								
7.5								
8								
8.5								
9								9
9.5								15
10								18
10.5								14
11								10
11.5								16
12								18
12.5								32
13								35
13.5	2							
14								
14.5	1							
15								1
15.5								
16								4
16.5								
17								
17.5								4
18								6
18.5								12
19								
19.5	1							37
20								22
20.5								19
21								21
21.5								8

Transect 2	WETLAND PLANTS						dead
QUADRAT	'Ahu'awa	Kaluha	'Ae'ae	'Uki	Rhizoph.	Batis	'Ahu'awa
22		23	13		6		
22.5		28	11		2		
23		18	6		3		
23.5		21	3		2		
24		32	1		1		
24.5		23	2		2		
25		3			1		
25.5		2					
26							
26.5							
27							
27.5							
28							
28.5			2		1		
29							
29.5							
30						1	
30.5							
31							
31.5							
32							
32.5							
33							
33.5							
34							
34.5							
35							
35.5							
36							
36.5							
37							
37.5							
38							
38.5							
39							
39.5							
40							
40.5							
41					1		
41.5					1		
42					2		
42.5					3		
43			15		1		
43.5			30		2		

Transect 2	UPLAND PLANTS							Bare
QUADRAT	H. Curr	Pluchea	Naupaka	Naio	A'ali'i	Colubrina	Jacquem.	substr.
22	4							4
22.5	4							5
23	17							6
23.5	18							6
24	8							8
24.5	1							22
25								46
25.5								48
26								50
26.5								50
27								50
27.5								50
28								50
28.5								47
29								50
29.5								50
30								49
30.5								50
31								50
31.5								50
32								50
32.5								50
33								50
33.5								50
34								50
34.5								50
35								50
35.5								50
36								50
36.5								50
37								50
37.5								50
38								50
38.5								50
39								50
39.5								50
40								50
40.5								50
41								49
41.5								49
42								48
42.5								47
43								34
43.5	1							17

Transect 2	WETLAND PLANTS							
QUADRAT	'Ahu'awa	Kaluha	'Ae'ae	'Uki	Rhizoph.	Batis	dead	caliche
44			21		4			
44.5			8		4			
TOTAL	1383	219	995	96	50	3	10	557
MAX	50	9	50	39	2	1	3	50
MIN	1	1	1	2	1	1	1	11

Transect 2	UPLAND PLANTS							Bare
QUADRAT	H. Curr	Pluchea	Naupaka	Naio	A'ali'i	Colubrina	Jacquem.	substr.
44	11							14
44.5	33							5
TOTAL	132	10	110	92	11	45	4	7184
MAX	20	2	24	14	6	19	2	50
MIN	1	1	1	2	1	1	2	1